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STANDARDS OF LIVING AS FUNCTIONS OF SCIENCE AND OF SOCIAL ORGANIZATION[1]

By Dr. STUART A. RICE

CHAIRMAN, U. S. CENTRAL STATISTICAL BOARD

THE purposes of my paper as first projected for inclusion in the symposium on "Science and Society" were: "(1) to take stock of the extent to which the standards of living of the people in the world have been raised in recent times; (2) to examine the extent to which production must still be expanded in order to provide satisfactory standards of living." It was hoped thus to "provide a factual basis on which to consider the needs for further applications of science to productive enterprise."

The phrasing of these intended specifications implies an attempt at statistical precision. "Take stock," "extent," "raised," "factual basis," "further applications," are expressions appropriately used in discussing measurable and measured or enumerated phenomena. Alas! Quantitative evidences of changes in the world's standards of living are not to be here presented. The concept "standard of living" is a will-o'-the-wisp. Its incarnate shapes and dimensions at different times in different climes have not been calibrated.

Alfred Marshall avoids the term "standard of living"[2] and distinguishes between the *standard of life,* meaning "the standard of activities adjusted to wants," and the *standard of comfort,* "a term that may suggest a mere increase of artificial wants, among which perhaps the grosser wants may predominate." "A rise in the standard of life implies an increase in intelli-

[1] Condensed from the address on "World Standards of Living" of the retiring vice-president and chairman of Section K, of the American Association for the Advancement of Science, at the Ottawa session, June 28, 1938.

[2] "Principles of Economics," 8th ed., Chapter XIII, on "Progress in Relation to Standards of Life."

gence and energy and self-respect; leading to more care and judgment in expenditure, and to an avoidance of food and drink that gratify the appetite but afford no strength, and of ways of living that are unwholesome physically and morally. . . . It is true that every broad improvement in the standard of comfort is likely to bring with it a better manner of living, and to open the way to new and higher activities; while people who have hitherto had neither the necessities nor the decencies of life can hardly fail to get some increase of vitality and energy from an increase of comfort, however gross and material the view which they may take of it."

The concepts underlying factual studies of standards of living probably include now one and now the other of Marshall's standards. In "The Encyclopaedia of the Social Sciences,"[3] Carl Brinckmann asserts that "the concept . . has yet to be worked into definitive form." Brinckmann himself comes closer than Marshall to precise definition when he says: "The underlying idea of a standard of living would seem to be that of a particular system of wants as connected with a specific system of productive services designed to transform these wants into efficient demand in the market." This concept must be distinguished not only from Marshall's standard of life and standard of comfort but also from what are sometimes called the "plane of living" and the "cost of living," although all these to a certain extent approach each other.

The standard of living, to expand Brinckmann's definition, is a composite. On one side it is a "system" or complex of wants. This complex, in turn, is composed in part of certain natural or physical requirements for existence and in part, and more significantly, of material and immaterial elements related to the customs, attitudes and valuations peculiar to the group. These latter are not subject, as Marshall implies in describing the standard of life, to judgments outside of the group itself as to what is wholesome or "unwholesome . . . morally," conducive to a "better manner of living" or promotive of "higher activities." There is room for many differences of evaluation and of reference when such terms are used. The Florida kidnapper and murderer of little Jimmy Cash "claimed he wanted the better things of life for his wife and himself."[4]

From the side of human wants, then, a standard of living is a mixture of physical or natural *and cultural* elements. In its second, or complementary aspect, a standard of living involves the possibility of satisfying wants. The wants must not be merely conceptual, fantastic or utopian. They must exclude the moon, even though the baby cries for it. Ownership of a motor car may be part of the standard of living of a well-paid American workman, even though he does not have one in his possession; while the standard of living of a Mexican peon may exclude this item because the possibilities and expectations available to his status make such ownership fantastic. Brinckmann says: "Standards of living, besides representing the natural or physical conditions of certain minima of existence, derive their greatest economic and social significance, first, from the ways these conditions are reacted upon and developed, so that they result in cultural instead of natural minima, and, second, and even more important, from the productive contributions that societies or groups are able and willing to make in order to attain such minima."

All this bears upon the task initially undertaken for this paper because it indicates that the supplementary concepts of "raising the standard of living" and "measuring improvements in standards of living" are mixtures of definite and realistic and of indefinite or unreal elements.

If the standard of living includes the "natural or physical conditions of certain minima of existence," these conditions, taken together, will comprise, as it were, a *minimum* minimum standard of living. This will include certain ranges of altitude, of heat and cold, of access to food, of means, in general, for the survival and prolongation of life. These things are capable of examination by quantitative methods. While some of them may be related to human existence as constants or discrete phenomena rather than as variables, their combined effects produce variation in the possibilities of living or not living. The transition of desert to fertile land through irrigation would represent a gain in the *minimum* minimum standard of living, as would also the recession of the frontier for wheat production in western Canada—both of them triumphs of applied science. So, too, would medical discoveries. Indexes of change in the *minimum* minimum standard of living could be found in periodic data showing the numbers of the world's population, or in comparisons, at intervals, of the average expectation of life.

When we pass from the natural or physical conditions of existence and examine the cultural components of a standard of living, we immediately encounter individual and social values, improvements in which can not be assumed or measured except in relation to artificially fixed points of reference. Universal agreement upon these points of reference will be rendered difficult if not impossible for all time to come because of the great diversity of human cultures.[5]

[3] "Standards of Living," Vol. 14, p. 322.

[4] Statement of the Chief of the Federal Bureau of Investigation, *The New York Times*, June 11, 1938, p. 1.

[5] Cultural anthropologists distinguish between material culture and immaterial culture. The latter would include such items as beliefs, speech habits, ethical ideas or scientific knowledge. Material culture would include dwellings, machines, incendiary bombs, microscopes and frying

The assumption which is general in Euro-American culture that standards of living are continuously improving as a result of scientific development appears to be a thinly disguised version of the belief in social progress. The concept of social progress has been somewhat discredited and confused by events since the outbreak of the World War. The development of communism and of fascism are cited by Russians and Germans, respectively, as evidences of social progress, while the success of both doctrines is responsible for dimming the belief in progress in the United States and Canada.

If standards of living are functions of cultural standards of value which are highly diverse, no means seem available for accurate comparisons of the standard of living among races and nations, or among groups and classes within the same racial or national structure or within the same nation or group at differing periods of time. Even individuals of the same group and social status may have widely differing standards at the same moment of time.

May I illustrate by describing an afternoon which I spent some years ago at the English country home of one of the world's leading social scientists. I sat with him in a small, frugal study, chilled to the bone by the raw drizzle through which we had walked from the station. It contained tiers of books, a simple oak table, two dilapidated chairs and a tiny grate containing a single, partially burned but unlit coal. That was all.

Outside in the garden he proudly exhibited neat rows of vegetables and—a rock-garden. The younger and middle-aged generations, he said sadly, are rushing around in motor cars and losing their capacity to construct and enjoy rock-gardens. This he regarded as a definite loss to living standards—a decline in one of the recognized norms of the English home, important in itself no less than as a symbol of that quiet contentment and domestic stability that makes every Englishman's home his castle.

Figures are no doubt available showing the production and use of motor vehicles in Great Britain, with estimates of passenger miles driven. These doubtless would show upward trends since the World War. But I am sure that no indexes have yet been devised to determine the relationships of such figures to the essential values in his nation's standard of living that alone seemed worth preserving to this distinguished scholar.

How, then, may we determine "the extent to which the standards of living of the people of the world have been raised in recent times?" I believe that there is no satisfactory quantitative answer to this problem. The question is on a par with such others as: To what extent have men gained wisdom in and satisfaction from the spending of their incomes? What improvements can be shown in the world's choices of occupations? In how far have human customs and manners been improved? Such questions are unreal, first, because of the absence of norms from which to measure deviations; second, because they assume the existence of criteria external to the productive system of which, in actuality, such criteria must be a part. One is reminded of the question allegedly asked of Abraham Lincoln, "How long should a man's legs be?" And his alleged reply, "Long enough to reach the ground."

The only practical means which I can discern by which to approach such questions have already been disclosed. First, we may agree to accept as a norm some pattern of standards which is held for the moment by a given group, presumably our own. This solution is implicit in all missionary activity, political, economic or religious. It is especially congenial to a nation which finds its motion pictures, its manners and its forms of industrial organization increasingly demanded or imitated throughout the world. As other peoples seek to become more like ourselves it is easy to agree that their standards of living are improving, and it would probably be possible to devise some indexes of the process.

For example, we might reduce to an annual index the world total, broken down by countries, of exhibitions of motion picture films or even of theater attendance. (The data required are not, I believe, available; but they could become so.) The areas of higher and lower living standards, as gauged by the index, would be clearly disclosed. If the land of Ghandi, who, I believe, spurns Hollywood art no less than our mechanical gadgets, should appear as one of the darker areas on the map, this would substantiate the vast superiority of American standards. Those who do not admire our gods show themselves to be heathen; and being heathen, what would you expect? However, the darker areas would be a challenge to the evangels of higher standards. Experience has shown that sales resistance can be overcome, and intensification of marketing efforts would be indicated. It is largely by such efforts that living standards, in the sense that I now employ the term, have actually been raised throughout the world.

A second approach to the problem of gauging im-

pans. Theoretically, it might be possible to obtain periodic quantitative measures of material culture, by weight, by number of units, by monetary value, by variety or otherwise. Thus it has been estimated that one million distinguishable types and varieties of commodities enter into trade in the United States, and this might be taken as a measure of our material culture. The relation of the material culture to standards of living depends upon its relationship to the *minimum* minimum standard or, more often, to the values contained in the immaterial culture. Thus increases in the quantity of opium in the United States would be increases in its material culture but probably not in its standards of living. A new aqueduct to supply pure water to a city, on the other hand, would be an unquestioned addition to the standard of living because it would be favorable to human life itself.

provements in world standards of living is to limit the examination to the *minimum* minimum standard. This has incidental statistical advantages, since it tends to avoid many questions of qualitative differences, of national or group averages, of deviations within the group, of the valuation to be placed on the consumption of leisure and the disvaluation to attach to forms of discontent arising from constraints upon individuals. Thus human life may be postulated as a good in itself. The development during several centuries past of the medical, hygienic, nutritional, political, sociological, productive and distributive sciences, technologies and arts, has brought about increases in the expectation of life and possibly also in opportunities to be born. The net result, in any event, has been an increase in the world's population. To science may be attributed the primary credit for the fact that there is undoubtedly more human life on our planet to-day than at any time before in its known history.[6] This brings me to the second of my initial undertakings: "to examine the extent to which production must still be expanded in order to provide satisfactory standards of living" and thus to "provide a factual basis on which to consider the needs for further applications of science to productive enterprise."

As already indicated, specifications for a "satisfactory" standard of living of world-wide application are unrealistic. At the same time, I believe that living standards in my own country are far from satisfactory, and that in most of the remaining countries of the world they are probably even less so. One third of the nation, according to our President, is "ill-fed, ill-clad and ill-housed." But such negative statements are easier to make than are their complementary positives. I could not say when, if all individual real incomes were to be raised at the same constant rate, "one third" would have been reduced to zero. Once the nation had attained a "satisfactory" level for every one, we should in the process have developed new opinions as to what is "satisfactory."

Two assumptions in my initial project caused me the most difficulty; first, that satisfactory standards of living are to be achieved by the expansion of production; second, that such an expansion depends upon "further applications of science." Both of these are partially true but omit a major consideration. In the case of the second, I can resolve the difficulty by placing my own interpretation upon the term "science."

The overlooked consideration is that natural science alone, without social organization to sustain it and put its achievements to work, would be a modern form of monasticism. By "social organization" I do not refer to the organization of scientific laboratories, faculties, staffs and associations merely; but rather to the entire structure and organized processes by means of which men live, produce and consume together. I mean in combination what the economist means by "the economy," the sociologist by "the society" and the political scientist by "the state," in so far as these differ. As an economy the system may be capitalistic or communistic or something between; as a society it may veer toward individual freedom or toward autocracy; as a state it may be democratic or totalitarian. Social organization of some kind there must be if the masses of men are to receive benefits from the laboratories and cloisters of the men of science.

A recent Associated Press dispatch from Shanghai will illustrate the way in which natural science, when implemented by social organization, may extend the lives of persons who are utterly lacking in knowledge of its aims and methods; "In this war-shocked, disease-ridden city any resistance on the part of a Chinese war refugee against vaccination is efficiently countered by health workers with strong-arm methods. While a sock on the jaw or the application of a half-Nelson may seem a bit drastic, such measures are often the only means of overcoming the Oriental fear of a bit of arm-scraping and a dose of vaccine." In its essentials, this mode of applying science through social organization is familiar to all of us.

But while social organization in cooperation with natural science is saving lives, social *disorganization*, especially on an international level, is destroying the lives and the cultural achievements of millions and reducing the standards of living of hundreds of millions. Science has been unable to prevent and in some respects has actually furthered social disorganization. How long will social organization, in forms competent to translate natural science into living standards, be able to endure as against the forces throughout the world making for war and other forms of social disintegration?

In the United States, we find: One third of the nation ill-fed, ill-clad and ill-housed; tremendous surpluses of food products and cotton; the producers of lumber, steel, glass, cement and other building materials operating well below capacity. Are the greater possibilities of improving standards of living in the United States to be found in expansions of production or in improvements in distribution? In further applications of science to productive enterprise or in perfecting the social organization?

In the *long run*, in my opinion, further applications of science to the increase of production will be required. From both the short-run and the long-run standpoints improvements in the mechanism of distribution and a recasting of present forms of social organization are essential. What shapes the recasting

[6] *Cf.* "Science," F. R. Moulton, SCIENCE, June 18, 1937, Vol. 85, No. 2216.

will produce I do not know. *Laissez-faire* in my opinion, and that of the publication *Fortune,*[7] is dead. The forms of departure from *laissez-faire* known as fascism, communism and national socialism all seem to me highly objectionable. I believe that ways can be found to reconcile social and political democracy with social efficiency in a system which will permit the untrammeled development of science and the distribution of its benefits to all the people. Hence, it would appear that *just now,* in accordance with the economic principles of *increasing* and *diminishing returns,* additional increments of scientific development would be most profitable in the fields of distribution and in respect to the perfection or recasting of social organization. These are tasks for social science rather than natural science.

These are questions of deadly seriousness for our present industrial civilization. Since the beginning of the industrial revolution in Europe, there has been a general upward trend in the possibilities of life—the *minimum* minimum standard of living. There has also been a great increase in material culture, though whether this has contributed more to the "standard of life" or to the "standard of comfort," using Marshall's distinction, is not certain.

Prior to the World War there seemed to be progress in the development of certain elements of immaterial culture which most people like ourselves deemed "desirable." These included "democracy," "civic consciousness," personal liberty, liberalism, universal education, cultural leveling, the free development of individuality, scholarship, research, tolerance, sophistication, urbanity, cosmopolitanism, pacification and perhaps pacifism, world-wide economic and intellectual interdependence, international justice, international law, humane sentiment, attention to personal cleanliness and appearance, esthetic sensitivity and appreciation, "sincerity" in architectural standards and more frequent and more rapid intercommunication over wider areas. Most of these are still regarded as desirable by people such as we. Others are being widely challenged and some have an interest mainly historical. The war brought subtle and often imperceptible changes in our valuations. Even in 1918, John Maurice Clark, Walton H. Hamilton and Harold G. Moulton pointed to "the establishment of new industrial standards, the enlarged domain of control, *the changes in personal habits and the newer conceptions of what is worth while in national and individual life*"[8] that would affect the transition from war to peace.

Before the war, the social mechanism, both internationally and within each nation, was becoming more subject to failure of parts to intermesh. The sacrifices of war were made endurable to democratic peoples by the faith that it would recast the worn-out parts and reset the ill-fitting gears. It was a war to make the world safe. These faiths have been very largely dissipated. World tensions have been growing more rapidly than before the war to end war. What meanings can be obtained from these experiences? What are the near-term prospects for human life and civilization on this planet? The world confronts two types of hazards, in my opinion: first, a catastrophic breakdown in its social organization; second, a slow disintegration and decay of social organization.

I have referred above to "war and other forms of social disorganization." This really begs an important question. Warfare has served at many historical junctures as a force making for social unification, organization and cultural diffusion; just as slavery, also, has had its periods of usefulness as an instrument of progress. But warfare, with the World War marking a turning point, has radically changed its character.

Traditionally, war has been a conflict between armies. The morale of the civilian populations behind the lines was usually strengthened by it, and nations could emerge from war with the social fabric more firmly inter-knit than before. To-day there are no lines to stay behind. The destruction of the morale and social organization, not to speak of the civilian lives, of the enemy nation have become major military objectives. Technological progress has facilitated the prosecution of these objectives, as by the development of aerial warfare. Technology has also increased the vulnerability to attack of social organization; first, by contributing to social complexity; second, by increasing social dependence upon material structures open to physical attack, such as central power stations, transportation and communication systems, and concentrated centers of manufacturing production.

For these reasons, a catastrophic breakdown in social organization, as a result of another world war involving unparalleled destructive efficiency, seems a distinct possibility. This is the forecast of H. G. Wells in his "Things to Come."

The possibility of slow decay in social organization arises from more subtle forces of disintegration at work within the social structure itself. The retardation of the birth rate; the prospective stabilization or decline of national populations; the weakening or disappearance of traditional sanctions for individual behavior; and the failure, in western liberal, capitalistic countries, to devise efficient means for the distribution of the products of technology, seem to be among these forces.

The existence of both of these hazards is an evidence of the seeming limitations upon man's capacity to

[7] "Business and Government," *Fortune Magazine*—February, March, April, May, 1938.

[8] Clark, Hamilton and Moulton, "Readings in the Economics of War," University of Chicago Press, p. 6, 7. Italics are mine.

direct a mechanism so complex as his own social organization.

A characteristic of periods of social stress and strain seems to be the tendency of peoples to seek escape into phantasy or *other-worldliness* from the over-difficult perplexities of real life. A leading economist said to me during the trough of the depression that we were headed in the United States for the "——est religious revival that this country has ever seen." His expectations were not realized, perhaps, because of the economic recovery that rapidly ensued thereafter. However, we see many evidences to-day of the same basic phenomenon to which he alluded. With a certain attitude of desperation the world is sacrificing its hopes of higher living standards on behalf of towering, nonproductive armaments; meanwhile seeking psychological compensation in phantasy. The unprecedented "success" of Walt Disney's "Snow White and the Seven Dwarfs" and the wide appeal of James Hilton's "Lost Horizon" illustrate the point.

I think it significant that the present-day pessimism in the nations which are striving to preserve simultaneously liberalism, capitalism and democracy, is not engendered by fear that natural science and technology, of themselves, may fail to provide foundations for further expansions of production. It arises from fear of universal warfare and the general breakdown of existing social institutions. Science itself, in the latter event, might perforce be compelled to retreat again into the cells to which it was once confined by medieval theology. Even now, in large and important nations, science has been commandeered by the priests of force and intolerance. Without understanding that science can prosper only when abundantly supplied with the air of freedom, they would drive it to serfdom and prostitution on behalf of bastard political and anthropological doctrines.

We whistle and believe that "it can't happen here." This keeps up our courage. I believe that we must do more. Natural science and social science must join their efforts in undertaking the realistic task of constructing social organization, national and international, that can function and produce for the well-being and improvement of mankind. Only then can we believe with confidence that improvements in world standards of living are a reality.

OBITUARY

HEINRICH WILLIAM POLL

DR. HEINRICH POLL, anatomist and biologist, died suddenly on June 12, 1939, in his sixty-second year. Long denied common decencies of human living in the home country which he loved even to the end, he had found refuge in Lund, Sweden. It was here that he died after but a few days of freedom, tragically burdened by concern over the welfare of Mrs. Poll (Dr. Clara Poll Cords), who remained in Germany.

Poll was born on August 5, 1877, in Berlin. In 1900 he received the degree of doctor of medicine from the University of Berlin, where during 1899 he served as assistant to Oscar Hertwig. Appointed privatdocent in the Berlin Institute of Anatomy and Biology in 1904, he was elevated to professorship in 1907 and to extraordinary professorship in 1922. In 1924 he removed to the University of Hamburg, to occupy the ordinary professorship and to serve as director of the Institute of Anatomy and Human Genetics. Displaced from this position in 1934, he remained thereafter without institutional connection.

In 1928–29 Poll presented the first series of Flexner Lectures at Vanderbilt University, and on the occasion of this visit in the United States lectures were given also at the University of Chicago, Columbia, Harvard, Washington University and Yale.

Poll's first publications appeared in 1896; as a youth in the late teens he was already driven by the urge which made of him a scholar in all that the true sense of the word implies. That urge never deserted him. Even through the dark years which followed 1934 Poll did not cease his studies, hampered though he was by material obstacles and stresses, which for another might have stultified productive work. His bibliography, numbering over one hundred titles, closes with two papers in press, and other investigations were left unfinished.

His studies for the most part lie in three fields: physical anthropology, the endocrines and genetics. It is significant to note that his two first publications are concerned respectively with physical anthropology and endocrinology. Both these interests endured through a working career of over four decades, and for a large part of this period genetical investigations claimed a share of his attention. To each of the three fields Poll contributed distinct advances, not only directly but through his students as well. His most important work in physical anthropology is perhaps that concerned with finger prints, a subject which commanded first place in his interests during the later years. He developed a novel and revealing methodology, with the use of which he investigated racial variation, geographic variation within single races, constitution and symmetry. In endocrinology, his early demonstration (1896) of survival of transplanted adrenal tissue, the discovery of adrenal-like elements in invertebrates and a series of studies on the interrelation of the sex glands and adrenal are noteworthy. His

genetical studies chiefly relate to hybridization of birds. Poll (1914) was among the first to appreciate the promise of the twin-method and to utilize it in genetical research.

Poll's stimulating discussions of scientific matters would alone hold him close in the memories of those who knew him. But his friends have gained much more from the man, the warmth and fullness of his understanding, be it in sharing a sunrise or in united attack on some entangled problem.

HAROLD CUMMINS

DEPARTMENT OF ANATOMY,
TULANE UNIVERSITY

RECENT DEATHS

DR. ALGERNON COOLIDGE, since 1911 professor emeritus of laryngology at the Harvard Medical School, died on August 16 at the age of seventy-nine years.

DR. CLEMENT ROSS JONES, since 1932 dean emeritus of the College of Engineering of the West Virginia University, died on August 16 at the age of sixty-eight years.

DR. ALBERT COULSON BUCKLEY, professor of psychiatry at the Graduate School of Medicine of the University of Pennsylvania and honorary consulting psychiatrist at Philadelphia General Hospital, died on August 17 at the age of sixty-six years.

SCIENTIFIC EVENTS

THE NEW BRITISH NON-FERROUS METAL RESEARCH LABORATORIES

OLIVER STANLEY, president of the British Board of Trade, opened on June 29 the new laboratories of the British Non-Ferrous Metals Research Association in London. According to an article in the London *Times*, in the entrance hall he unveiled a bronze portrait plaque, erected as a memorial to Thomas Bolton, who from 1920 to his death in 1937 was chairman of the association.

The new premises provide a center for the research necessary in the metallurgical industries. Non-ferrous metals have been extensively used to show their advantages in modern building. The heating installation, electrical conduit, certain water supplies, plumbing and principal rain pipes are in copper; other water supplies are in BNF ternary lead alloy No. 2; water fittings in nickel silver and bronze; the principal stair balustrade has a nickel silver handrail, with anodized aluminium tubular standards, and door furniture is of nickel silver, anodized aluminium and bronze.

At semi-basement level there is a melting shop, with furnaces of many kinds, and nearby is a galvanizing and welding shop. The mechanical testing laboratory includes a constant temperature room, maintained at 68 deg. F., with a control to within plus or minus half a degree, so that no two points in the room differ by more than one degree. The machine shop includes a guillotine capable of cutting sheet steel up to 18 gauge. The physics laboratory is equipped with highly sensitive instruments for spectrographic analysis, general physical testing, thermal conductivity, specific-gravity determinations and reflectivity measurement.

In one of the two rooms reserved for metallography, photographic work is carried out on a large projection microscope with which magnifications from three to 2,500 diameters can be obtained. There are also chemistry laboratories, a pyrometry and heat treatment laboratory, laboratories for investigating corrosion, a general laboratory, a development department which interprets and demonstrates the result of the association's researches, offices, a library containing 4,000 books and 20,000 pamphlets and a store room.

The building is steel framed, with brick panel walls. Easy access to the flat roof makes it convenient to expose specimens to atmospheric corrosion.

The British Non-Ferrous Metals Research Association is a national organization of producers, manufacturers and users of non-ferrous metals, established in 1920 for the promotion and use of scientific knowledge in industry. It has grown to a large organization with nearly 300 subscribing members and a total income exceeding £30,000 a year, a proportion of which is received from the Department of Scientific and Industrial Research on a basis which provides for increased government grant as the industrial income increases. The association conducts researches on technical problems of common interest to groups of members and assists in the application to industrial practice of its own research results and of other advances in science.

EXPEDITION TO THE PACIFIC ISLANDS

AN expedition to the Pacific Islands, under the auspices of the National Geographic Society and the University of Virginia with the cooperation of the U. S. Coast Guard, will sail from San Francisco shortly after the middle of September on board the U. S. Coast Guard cutter *Hamilton*, a 328-foot vessel.

Professor Wilbur A. Nelson, of the University of Virginia, will be the leader of the expedition and in charge of its geological work. Dr. C. S. Piggot, geophysicist, of the Carnegie Institution of Washington, will make studies from cores of mud taken from the ocean bottom. Professor Maurice Ewing, geophysicist of Lehigh University, will carry on gravity investigations at sea and will make special studies by means of

artificial "earthquakes" produced by explosions on the ocean floor. Lieutenant A. J. Hoskinson, geophysicist of the U. S. Coast and Geodetic Survey, will measure gravity on land. Dr. J. W. Green, geophysicist of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, will conduct magnetic investigations, and Dr. Waldo L. Schmitt, marine biologist of the Smithsonian Institution, will make studies of sea life.

Other members of the expedition are F. Barrows Colton, science writer of the National Geographic Society, and R. H. Stewart, staff photographer, both of Washington; Jon M. Larson, of Princeton, N. J., radio engineer of the National Broadcasting Company; and the following assistants: R. M. Maddex and George T. Nelson, of Charlottesville, Va.; Leslie Manning, of Baltimore; Charles R. Smoot, of Washington, D. C.; A. C. Vine, of Garrettsville, Ohio; E. G. Uhl, of Elizabeth, N. J.; J. L. Worzel, of Staten Island, N. Y.; and O. Roy McClunin, of Washington, D. C. Leon J. Canova, 2nd, of Washington, is the secretary of the expedition.

In addition to the eighteen members of the expedition, the *Hamilton,* under the command of Captain Stephen Safford Yeandle, will be manned by a crew of 110. The ship will cover the island-studded area of the central and south Pacific extending 5,000 miles in an east-west direction and 2,500 miles north-and-south. Landings will be made on many of the islands in order to establish bases for instrumental observations.

COURSES IN PUBLIC HEALTH AT HARVARD UNIVERSITY AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A NEW course, designed to train school supervisors, and especially supervisors of education in health, in the technique of educating the public concerning the protection and promotion of health, will be offered at the Harvard School of Public Health beginning this September.

The course, open to college graduates and extending one or two years, has been planned in recognition of the growing realization that those who are engaged in health education work must not only understand individual health measures, but they must also know what public health is, what its aims are, and what administrative measures are used in the fulfillment of its aims. Because it is equally essential that the student understand educational techniques, the Harvard Graduate School of Education will cooperate with the Harvard School of Public Health in giving this new course.

There will be no prescribed curriculum; each student will be assigned a personal program after an individual conference to determine his or her needs, in the light of prior training and experience. Credit may be granted for previous academic work in public health and in educational methods, and for experience in the field.

The training offered in this course is based on the principle that the person going into the field of health education needs first of all a basic knowledge of anatomy, physiology and the fundamental medical sciences. He will need to know the diverse functions of health departments and how such departments are organized. The student will, therefore, according to his individual needs, be assigned to work in the Harvard School of Public Health, in the Harvard Graduate School of Education, in the Harvard Faculty of Arts and Sciences, in Radcliffe College and in the Harvard Medical School.

A graduate course in public health engineering has been established at the Massachusetts Institute of Technology in the department of biology and public health, of which Dr. Samuel C. Prescott is head. This new course will consider such subjects as water supplies, water purification, sewerage, industrial waste disposal, stream pollution and purification and the sanitation of shellfish grounds. In addition, consideration will be given to the most advanced practice in the collection and disposal of refuse, sanitation of swimming pools, rural communities and camps, as well as the sanitation of food supplies, stores and restaurants. Students will also receive instruction in the relationship of insects and rodents to disease; the atmosphere in relation to health and comfort, housing and health, school sanitation and industrial hygiene. There will be training in the organization and activities of health departments, the collection, analysis and interpretation of vital statistics, epidemiological methods, the value and conduct of public health surveys, and the use of standard health appraisal forms.

The course will lead to the degree of master of science in one year, and will be open to qualified men of outstanding scholastic attainment and professional promise who are graduates in engineering of a recognized school or college. Candidates must have had at least one year of experience with a city, county or state department of health, the United States Public Health Service or some other recognized health agency.

Professor Murray P. Horwood, of the department of biology and public health, will direct the courses in public health engineering and vital statistics. Professor T. R. Camp, of the department of civil engineering, will give the course in hydraulic and sanitary engineering and sanitary design. The courses in health department practice and industrial hygiene will be

given by Professor Clair E. Turner and the course in sanitary biology by Professor Marshall W. Jennison. Students will be required to present a satisfactory thesis dealing with some original investigations.

ESTABLISHMENT BY THE AMERICAN MATHEMATICAL SOCIETY OF A NEW PERIODICAL

THE American Mathematical Society has received grants from two foundations to found a new international mathematical abstracting journal to be known as *Mathematical Reviews*. During the past quarter of a century while the United States and Canada have been gradually assuming a more prominent part in mathematical research, there has been sentiment expressed from time to time among mathematicians that there should be a review journal sponsored by American organizations. But doubts as to whether the scientific and financial resources could be spared caused the postponement of the undertaking. However, the rapid growth of American mathematical resources and the availability of funds have resolved these doubts, and it has been decided to proceed immediately.

The first number of *Mathematical Reviews* is to appear late in 1939 or early in 1940; the material to be reviewed begins with the latter half of 1939. It is proposed to review all fields of pure mathematics and also those of applied mathematics and mathematical physics which are of pronounced interest to mathematicians. The new journal, which will be issued approximately once a month, will contain several thousand reviews annually and will run to approximately eight hundred large double-column pages. Professors J. D. Tamarkin and Otto Neugebauer will be the first editors. A strong group of collaborators for the initial period is assured.

The Carnegie Corporation has appropriated $60,000 for the new journal. The Rockefeller Foundation has made a gift of $12,000 to cover some of the initial costs. Brown University is housing the project and aiding in the editorial work. The American Mathematical Society and the Mathematical Association of America are each starting off with a subsidy of $1,000 for the first year. Annual subsidies are being sought from other organizations, and plans for the permanent financing of the project are being considered. On account of the subventions, the subscription price will be set below actual cost.

Partly with a view to aiding indirectly in the support of this journal, the Rockefeller Foundation has made a gift to Brown University for an experiment in the dissemination of mathematical publications through the distribution of microfilm. This money is to be used to augment the mathematical library at that university, a collection which is already internationally known as outstanding. Out-of-print journals will be put on film and made available to mathematicians; rare books of general use will be filmed; on request from a subscriber to the new journal, any article reviewed will be sent on film or as film-print. This service will be extended to all parts of the world at a price not exceeding cost.

AWARD OF THE CHANDLER MEDAL

THE seventeenth Charles Frederick Chandler Medal of Columbia University has been awarded to Thomas H. Chilton, director of the technical division of the engineering department of E. I. du Pont de Nemours and Company, Wilmington, Del.

Mr. Chilton was chosen "for his outstanding achievements in the discovery and formulation of principles underlying the unit operations of chemical engineering, and in the application of these principles to process development, equipment design and chemical plant construction and operation," according to the citation of the award committee. The medal will be presented to him on November 16, when he will deliver the annual Chandler Lecture on "Engineering in the Service of Chemistry."

The committee has issued the following statement in which it gives grounds for the award:

Mr. Chilton's studies have brought to light unknown facts concerning distillation, heat transfer, fluid flow and absorption—factors which are present in nearly every manufacturing process.

His published works are to the chemical engineer what the classics are to the student of literature. Principles discovered by his researches are used in the design and operation of chemical plants. There are few industrial processes involving chemical reactions in which his researches can not be applied.

In addition to conducting these researches, Mr. Chilton has developed a method of producing formaldehyde, of prime importance in the manufacture of synthetic resins, from methane, the chief constituent of natural gas. Because of the wide use of formaldehyde, this development has made many chemical processes more economical to operate.

The efficiency of the process by which nitric acid is manufactured from the oxidation of ammonia has been increased through Mr. Chilton's work. With the introduction of the nitrogen-fixation process into industry, ammonia became a relatively cheap and plentiful product. Its use as raw material for the production of nitric acid has greatly lowered the cost of the latter.

Heat and fluids are associated with nearly all chemical apparatus. In attacking the problem of how heat flows through various substances and determining the characteristics of fluid flow under different circumstances, he has clarified these fundamental subjects.

SCIENTIFIC NOTES AND NEWS

DR. E. D. MERRILL, administrator of botanical collections at Harvard University and director of the Arnold Arboretum, has been elected a corresponding member of the Institut national Genevois.

A FELLOWSHIP in the Rochester, N. Y., Museum of Arts and Sciences has been conferred on Dr. Carl E. Guthe, director of the University Museums and the Museum of Anthropology of the University of Michigan. Dr. Guthe's certificate of fellowship carried a citation which said, in part: "It is a recognition of your eminence in the field of museum administration and your leadership in the coordination of anthropological and archeological organizations resulting in the founding of the Society for American Archeology and to numerous important convocations of anthropologists and students interested in the study of early man in America."

T. E. WALLIS, reader in pharmacognosy in the University of London, has been awarded the Hanbury Medal of the Pharmaceutical Society of Great Britain.

DR. W. A. WESLEY, assistant director of the Research Laboratory, International Nickel Company, Bayonne, N. J., was awarded the annual gold medal of the American Electro-Platers' Society at its twenty-seventh annual convention in Asbury Park, N. J., in recognition of his paper on "Physical Properties and Uses of Heavy Nickel Deposits."

AT the fourth annual conference of the British Speleological Association, which opened at Swansea on August 5, a silver key was presented to Sir Cyril Fox, director of the National Museum of Wales, by Dr. R. R. Marett, president of the association.

PROFESSOR THEODOR VAHLEN, president of the Prussian Academy of Sciences, has been awarded the Goethe Medal for Art and Science by the German Chancellor.

PROFESSOR JAROSLAV PERNER, professor of paleontology in the Charles University, Prague, recently celebrated his seventieth birthday.

DR. R. E. COKER, head of the department of zoology and chairman of the division of natural sciences of the University of North Carolina, has been made Kenan professor of zoology in the place of Professor H. V. Wilson, who died on January 4.

DR. C. A. MCCUE, dean and director since 1920 of the Agricultural Experiment Station of the University of Delaware, who has been connected with the institution since 1907, has retired. George L. Schuster, professor of agronomy and research agronomist, has been appointed director.

DR. W. E. SHULL, associate professor of entomology at the University of Idaho, has been appointed head of the department. He succeeds Dr. Claude Wakeland, who has resigned.

DR. RICHARD O. SUTHERLAND, formerly of the University of Wisconsin and of Carleton College, has been appointed assistant professor of chemistry at Hamilton College, Clinton, N. Y. Dr. Asa Emanuel McKinney has been advanced to a professorship in that department, to take the place of Dr. Arthur Percy Saunders, who has been connected with the college since 1900.

DR. NATHAN SCHWID, of Montana State College, Bozeman, has been named assistant professor of mathematics at the College of Mines and Metallurgy, a branch of the University of Texas at El Paso. He succeeds Dr. Hugh L. Turrittin, who has resigned to join the faculty of the University of Minnesota.

DR. JULIA SOUTHERD LEE, formerly of Purdue University, has been appointed assistant professor of textiles and clothing at the Iowa State College.

DR. FRANCES L. HAVEN, associate professor at the University of Rochester School of Medicine and Dentistry, has been awarded a research fellowship by the National Cancer Institute at Washington.

DR. HUGH NICOL, of the Rothamsted Experimental Station, has been appointed scientific assistant to Sir John Russell, director of the station.

PROFESSOR ERNST FREUND has resumed his work as director of the Pearson Research Laboratory, which has been removed from Vienna to London. The laboratory, which has specialized in work on food chemistry and nutrition in its relation to cancer, was founded by Frederick Pearson, an American now living in England. Dr. Freund's assistant, Dr. Gisa Kaminer, who was for many years surgeon at the Rudolf Hospital in Vienna, is also working in the laboratory at London.

DR. JAMES R. WITHROW, of the Ohio State University, is one of a group of American chemical engineers who have been invited by the Swiss Government to visit the chemical and other industries of Switzerland in connection with the International Exposition of Swiss Industries at Zurich.

DR. JOHN A. KOLMER, professor of medicine at Temple University, Philadelphia, has been invited by the Health Section of the League of Nations to represent the United States at the fourth International Conference on the Serologic Diagnosis of Syphilis, to be held in Copenhagen from September 25 to October 6.

ACCORDING to *Industrial and Engineering Chemistry*, Charles M. A. Stine, vice-president in charge of re-

search at the E. I. du Pont de Nemours and Company, Inc., has accepted an invitation to address the Second International Chemical Engineering Congress, convening in Berlin during the week of June 23, 1940. Dr. Stine will represent the American Institute of Chemical Engineers, of which he is a director. His address, "Chemical Engineering and Industry," will be one of the four papers to be delivered during the general session. The other speakers will be Sir Harold Hartley, representing England; Georges Claude, France, and Richard Kuhn, Germany.

PROFESSOR FRANCESCO PENTIMALLI, professor of pathology at the University of Naples and a member of the Italian Parliament, arrived in New York on August 17. He plans to attend the International Congress of Microbiology in New York and the Cancer Research Congress in Atlantic City.

DR. RHEINHARDT DOHRN, director of the Naples Zoological Station, reports an active spring session at the laboratory this year. He states that an important result was the isolation of fertilizin (F. R. Lillie) from sea urchin eggs by Dr. Max Hartmann and his collaborators. Dr. Dohrn expresses regret that there were no American applicants this year. The American table is supported by the National Research Council under the direction of Professor R. E. Coker, chairman of the division of biology.

THE Advisory Council on Human Relations, authorized at the Richmond meeting by the executive committee of the American Association for the Advancement of Science, has organized with Dr. Horace B. English, of the Ohio State University, as *chairman,* and Dr. C. E. Lively, University of Missouri, as *secretary.* Other members of the council are: Dr. J. L. Hypes, University of Connecticut; Dr. C. C. Zimmerman, Harvard University; Dr. W. M. Krogman, University of Chicago; Dr. R. E. Coker, University of North Carolina; Dr. Douglas Fryer, New York University, and Fred C. Pederson, state forester, Charlottesville, Va. The council was appointed at the suggestion of the U. S. Forest Service to act as a central advisory and coordinating body for research into the human-relations problems of reforestation and soil conservation and such other problems as may arise.

THE twenty-ninth National Conference on Weights and Measures was held in Washington from June 6 to 9. The following officers were elected for the ensuing year: *President,* Dr. Lyman J. Briggs, director, National Bureau of Standards. *Vice-presidents,* Charles C. Read, state superintendent of weights and measures of New Jersey; C. E. Tucker, chief, State Division of Weights and Measures of California; H. N. Davis, supervisor, State Department of Weights and Measures of Vermont; A. J. Jenson, state inspector of weights and measures of North Dakota; Alex Pisciotta, director, Bureau of Weights and Measures of New York City; James O'Keefe, inspector of weights and measures, of Chicago, Ill. *Secretary,* F. S. Holbrook, National Bureau of Standards, Washington, D. C. *Treasurer,* George F. Austin, Jr., supervising inspector of weights and measures of Detroit, Mich.

THE British American Engineering Congress, dedicated to the subject, "Engineering Aids World Progress," will be held in New York City from September 4 to 8. It meets with the American Society of Mechanical Engineers, the Institution of Mechanical Engineers of Great Britain, the American Society of Civil Engineers, the Institution of Civil Engineers of Great Britain and the Engineering Institute of Canada and other participating engineering organizations. These include the American Engineering Council, United Engineering Trustees, the Engineering Foundation, the Engineers' Council for Professional Development, Engineering Societies Library, the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers, the Society of Automotive Engineers, the Society of Naval Architects and Marine Engineers, the Society of American Military Engineers and the Institute of the Aeronautical Sciences.

THE seventh congress of the Association pour la Documentation photographique et cinématographique dans les sciences will be held in Paris on October 12 and 13. Members will meet on the first day at the Palais de la Découverte and on the second day at the Musée Pedagogique de l'État. Further information may be obtained from Dr. Charles Claoué, 39, rue Scheffer, Paris, 16.

THE twenty-seventh International Congress of Americanists was opened on August 5 in Mexico City, under the patronage of President Cardenas, with an attendance of over three hundred students of archeology, anthropology and history. Dr. Alfonso Caso, director of the National Institute of Archeology and History, Mexico City, was elected president, and General Cardenas honorary president. The honorary vice-presidents include T. A. Joyce, lately of the British Museum, and M. Paul Rivet, of the Museum of Man in Paris. An excursion was made to the pyramids and the museum at San Juan de Teotihuacan.

THE twelfth International Congress of the History of Medicine will be held in Berlin from September 22 to 28, 1940, when the chief subjects for discussion will be the evolution of medicine in different countries from Harvey to Haller, the epoch of medical philosophers, introduced by Dr. Laignel-Lavastine, professor of the history of medicine in the faculty of medicine of the University of Paris, and the history of typhus, intro-

duced by Professor Zeiss, director of the Institute of Hygiene of the University of Berlin.

THE hundredth anniversary of the presentation of the daguerreotype process of photography to the French Academy by Louis Jacques Daguerre, father of photography, was commemorated on August 17 at the Eastman Kodak Building at the World's Fair with the opening of an exhibition of daguerreotype equipment, including a camera operated by Charles H. Tremaine, the only daguerreotypist in the United States. The exhibition includes an original daguerreotype by Daguerre, an 1837 photograph, which is the earliest existing still-life; an 1845 daguerreotype panorama of Niagara Falls, and many early photographs.

THE regular summer meeting of the Pennsylvania Academy of Science was called at Laporte, county seat of Sullivan County, on August 11, 12 and 13 by President R. W. Stone. Ninety-eight members and guests were present. Laporte is on the Allegheny Plateau at an elevation of almost 2,000 feet and is ideally situated for field trips, particularly in botany, as many rare plants occur in the neighborhood, including a number of unusual northern species. Field trips were held to the Haystacks, Lincoln Falls, Whirls End, High Knob and other points. On the evening of the eleventh, an out-of-door meeting open to the public was held. Talks, partly illustrated by lantern slides, were given on the local forestry, botany and geology. A correspondent writes that an unusually fine display of the aurora was visible that evening, adding materially to the interest of the meeting.

THE Rockefeller Foundation has recently granted Stanford University the sum of $200,000, for the continued maintenance, during a ten-year period, of a program of biological research supported since 1934 by previous grants from the same foundation. The project is under the general supervision of Professor C. V. Taylor, and has included individual investigations on biochemical factors in eye-color control in Drosophila, by G. W. Beadle; bioelectric phenomena in plant cells, by L. R. Blinks; the reorganization processes in induced encystment and excystment of ciliates, by C. V. Taylor; hybridization and embryonic transplantation experiments with Amphibia, by V. C. Twitty; the determination of polarity in developing ova, by D. M. Whitaker, and biochemical studies of bacterial synthesis, by C. B. van Niel.

ADDITIONAL facilities for the scientific study of problems confronting the fishing industry on the Atlantic Coast will be provided by the Bureau of Fisheries through the construction of a new laboratory building at the University of Maryland, College Park, to be built at a cost of $100,000. Preliminary plans call for the erection of a building to permit consolidated housing of the technological laboratory units now in operation at College Park and at Washington. A laboratory for research into West Coast fishing problems is maintained by the bureau at Seattle. The College Park building will provide for the first time similar unified facilities for the benefit of Atlantic Coast fishermen.

DISCUSSION

THE NEW NOMENCLATOR ZOOLOGICUS

SCIENTIFIC workers can not avoid a considerable amount of bibliographic drudgery, but in the nature of things some of this most necessary work can not be undertaken by single individuals. This is especially true in regard to generic and subgeneric names, which, according to the rules, may not be duplicated in the whole realm of zoology. Sherborn's "Index Animalium," listing, with bibliographical references, the generic names proposed up to 1850, has been invaluable; and particulars concerning later names may be found in the annual volumes of the *Zoological Record*. The various nomenclators, that of Scudder being the most important, listed the generic names, with dates. Yet with all these aids, there was clearly urgent need for a new nomenclator, bringing the subject up to date, and including some five thousand names which had been omitted from earlier lists. Such a work was projected by Dr. S. A. Neave, assistant director of the Imperial Institute of Entomology, in 1934. As a result of incessant labor by many workers, it has been completed, and is published by the Zoological Society of London. The first volume (A–C) is now published; three others (with over 900 pages each) will appear at intervals of about six months. The whole work is sold for eight guineas, post free, "a price which bears no relation to the initial cost, but which, it is hoped, will enable many individual zoologists, as well as institutions and libraries, to purchase copies." There are more than 225,000 entries, each occupying one or more lines of print. The generic names are in bold face and thus much easier to read than those in Scudder's work, which is in any case almost impossible to obtain, being long out of print. Looking up numerous names which are familiar to me, I have failed to detect any errors. The cost of preparation was borne by the Zoological Society of London, which publishes the work at its office in Regent's Park, London, N.W.8. Contributions towards the cost of printing were made by the Carnegie Corporation of New York, the Royal Society and a generous anonymous donor. Recorders were paid, but surely not in proportion to their labors.

J. R. le B. Tomlin unreservedly turned over for the use of the editor his great manuscript list of the generic names used for mollusca, on which he has been working for many years.

Such a work as this serves to emphasize the international and cooperative features of scientific work, and to show that it is possible to maintain a great republic of workers, without regard for race and without any external coercion. In the field of science we have a working League of Peoples, which may well serve as a model for other efforts to unite humanity for the common good.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

A NEW COLOR REACTION OF VITAMIN B_1 (THIAMIN, ANEURIN)

STUDYING the influence of pure synthetic vitamin B_1 (thiamin, aneurin) on blood phosphate fractions[1] by Fiske and Subbarow's technic we were surprised by the great increase of the values when thiamin was added. More accurate investigations showed that pure thiamin produced alone an intense blue color by the use of ammonium molybdate in sulfuric acid solution and aminonaphthosulfonic acid solution. This reaction being nevertheless non-specific permits, however, the determination of the vitamin when the concentration is above 100γ in pure aqueous solution. Since the color reaction follows the Beer's law it was possible to determine the optimal spectral zone for photometric readings. A Pulfrich spectrophotometer was employed, using filter S 72. The absorption index, $\frac{\text{concentration}}{\text{extinction coeff.}}$ was calculated and found to be 0.375. The technic for the determination is easy and rapid. To a 25 ml flask the thiamin solution (more than 100γ) is added together with 5 ml of a 2.5 per cent. ammonium molybdate solution in 3N sulfuric acid and then 1 ml of a 0.25 per cent. aminonaphthosulfonic acid containing sodium bisulfite and sodium sulfite (as prepared for blood phosphorus determination by Fiske and Subbarow).[2] The flask is filled to the mark with distilled water and the color read after 10 minutes using a 3 ml cup and filter S 72 in a Zeiss photometer. The extinction value is multiplied by 0.375 to obtain the thiamin in the sample.

When phosphorus is also present in the solution the color intensity represents the vitamin plus phosphorus content. By destroying organic matter with sulfuric-nitric mixture in another sample and neutralizing, then proceeding as above, the color developed represents only the phosphorus content. The difference between the first and the second determinations gives the thiamin content.

[1] G. G. Villela and A. M. Leal, *Compt. Rend. Soc. Biol. Paris*, in press.

[2] C. H. Fiske and Y. Subbarow, *Jour. Biol. Chem.*, 66: 375–400, 1925.

A more detailed study of this reaction will be published elsewhere.

GILBERTO G. VILLELA
ALUISIO M. LEAL

OSWALDO CRUZ INSTITUTE,
RIO DE JANEIRO, BRAZIL

ON THE NATURE OF FRICTION

FRICTION between solid surfaces is ordinarily thought of as due to the interlocking of surface irregularities. That static friction also depends on the molecular attractions between the surfaces has recently been shown in a series of experiments on the tangential force between two smooth, clean glass surfaces in contact.

We placed a short piece of fire-polished glass tubing inside of a longer straight glass tube. This tube had a sufficiently large bore so that the smaller piece could slide freely within it. This assemblage was thoroughly heated and carefully evacuated by means of an efficient mechanical vacuum pump after which the outer tube was sealed off in the evacuated state. The assemblage was then enclosed in a water jacket for temperature control and clamped on a tilt table. This arrangement permitted us to determine accurately the angle at which the small glass tube started to slide under gravity within the larger tube.

During the course of the experiments it was discovered that the static friction, as computed from the angle of slip, was much larger for surfaces baked in a vacuum than for surfaces which were exposed to the air in the laboratory. The lower friction of the exposed surfaces undoubtedly was due to a moisture and gas film between them.

Several assemblages were constructed, baked out and sealed under vacuum. In each the coefficient of static friction decreased almost rectilinearly with the number of passes of the slider. In one case, where both slider and enclosing tube were made of soft soda glass, the coefficient of static friction decreased to one half its original value in 44 passes of the slider.

The appearance of the sliding surfaces was much modified during the experiment. The fresh surfaces looked perfectly smooth under a microscope, but after a few passes of the slider the surfaces became pitted. The pits were approximately round and not elongated in the direction of the motion, showing that parts of the surfaces had been torn out as if welded junctions had been broken.

In all our experiments, using baked and evacuated apparatus, the coefficient of static friction decreased with wear. How far this decrease in friction continues is not known as yet, but it is not likely to go much below one half of its virgin value. Certain difficulties with the breaking of the outer tube due to the impacts of the slider have prevented us from extending the experiment indefinitely with a given tube.

Our interpretation of these results is that a large

fraction of the static friction between two clean, smooth glass surfaces in contact is due to molecular attraction between those parts of the surfaces which are so close to one another that their molecular adhesions come into play. This assumption would explain both the formation of the observed microscopic pits and the decrease in friction with decreased smoothness of the surfaces. If this interpretation applies to all friction between smooth, solid surfaces it would indicate that the friction is largely determined by the molecular attractions between the two surfaces in contact and by their mean distance apart.

G. W. HAMMAR
GORDON MARTIN

THE UNIVERSITY OF IDAHO

THE CONSCIENCE OF THE PAST AND THE PRACTISE OF THE PRESENT

INCREASING awareness among scientists of the barbaric uses to which their discoveries and inventions have so frequently been put—and in many cases are at the present time threatening the destruction of millions of human beings—has caused many scientists somewhat belatedly to take thought how best they can in future prevent such misuse of their labors. In our own day one of the greatest mechanical inventions of this or any other century, the aeroplane, has been turned into an instrument which power-crazed governments use to threaten not only the peace but the civilization of the world. It is therefore of peculiar interest for us to-day to hear what the inventor of the first airship, Father Francesco Lana (1631–1687), considered to be the strongest objection to his invention.

After enumerating the six technical objections which he foresaw to his invention (actually in his poverty he was unable to construct the ship), he goes on to say:

> Other Difficulties I see not, which may be objected against this Invention, besides one which to me seems greater than all the rest, and that is, That it may be thought, that God will never suffer this Invention to take effect, because of the many consequencies which may disturb the Civil Government of men. For who sees not, that no City can be secure against attack, since our Ship may at any time be placed directly over it, and descending down may discharge Souldiers; the same would happen to private Houses, and Ships on the Sea: for our Ship descending out of the Air to the sails of Sea-Ships, it may cut their Ropes, yea without descending by casting Grapples it may over-set them, kill their men, burn their Ships by artificial Fire works and Fire-balls. And this they may do not only to Ships but to great Buildings, Castles, Cities, with such security that they which cast these things down from a height out of Gun-shot, cannot on the other side be offended by those below.

This passage occurs in the author's "Prodromo," which was published in 1670. The first account and criticism of this work in English (probably by Robert Hooke) appeared in the *Philosophical Collections*, No. 1, 1680, pp. 18–29, and it is from this account that the translation given above is reproduced.[1]

M. F. ASHLEY-MONTAGU
HAHNEMANN MEDICAL COLLEGE,
PHILADELPHIA

SCIENTIFIC BOOKS

SCIENCE IN AFRICA

Science in Africa. By E. B. WORTHINGTON. New York: Oxford University Press, 1939. Pp. xv + 746. Illustrated. Maps. $4.00.

LORD HAILEY, the director of the African Research Survey, writes in the Foreword:

> This book is one of a series of reports prepared in connection with the African Research Survey. The problems of Africa, as they present themselves to those whose concern is with the development of the continent, are discussed in "An African Survey." The purpose of this volume is to summarize the present position of studies in the various sciences which have a bearing on African conditions.

Mr. Worthington starts in by pointing out the interrelations between branches of science, and then as an aid to the appreciation of the interdependence of scientific studies in Africa he mentions important points about the changing environment. For example, he says, "The picture really presented by Africa is one of movement, all branches of physical, biological and human activity reacting on each other, to produce what biologists would refer to as an ecological complex."

Mr. Worthington's first chapter deals with some problems of research in which he makes many practical suggestions arising from his investigations; for example, he points out the practical advantages of separating research organization from the executive

[1] A contemporary English translation of the relevant fifth and sixth chapters from the "Prodromo" is "The Aerial Ship, by Francesco Lana." The Aeronautical Society of Great Britain, London, 1910, 12°, pp. vi–7–27. The following are the studies which I have thus far been able to discover relating to Francesco Lana's invention: Wilhelm Balthasar, "An der Wiege der Luftschiffart. Francesco Lana und Barthol. Laurenço de Gusmao." *Frankfurter Zeitgemässe Brorchüren*, Hamm, Vol. 28, pp. 137–198, 1909; Anton von Brandis, "Studien über die Verfassungs-Geschichte der Gemeinde Lana," *Zeitschrift des Ferdinandeums für Tirol und Vorarlberg*, 3 Folge, Heft. 18, pp. 159–196, (Geschichtliche Abtheilung), Innsbruck, 1873; Angelo Ferretti-Torricelli, "Padre Francesco Lana nel terzo centanario dalla nascita," Ateneo di Brescia. Commentari, Brescio, 1931/32, pp. 331–390. See also Francesco Lana Terzi, *Magisterium Naturae, et Artis,* Brixiae, Libri 3, (1) 1684, (2) 1686 and (3) 1692.

work of the technical departments and placing it under separate director of research, as in the system applied in the Anglo-Egyptian Sudan. He then shows how such an organization might be set up, taking the three subjects of Agriculture, Veterinary Service and Forestry.

He emphasizes the value of financing research, especially that of the long-range type such as land survey work, from special funds raised by loan rather than from current revenue, which fluctuates so much with economic conditions.

He points out, under the "Waste of Research," that great quantities of material are published mainly in official documents, such as several department reports, bulletins, pamphlets, etc. Information in this form is not readily available to the scientific expert. He suggests adopting a common format for the separation of scientific fact from administrative detail, a standardization of form for statistical tables and some means of referring to the contents.

In recent years organizations for the promotion of scientific studies in the colonies have been formed in Paris, Brussels, Portugal and Rome as well as in South Africa and England, but in spite of all this, which is mostly recent, this continent, which has been developed almost wholly in the twentieth century, has been led by economic development.

The rest of the book is divided into 17 chapters dealing with the following subjects: Surveys and Maps, Geology, Meteorology, Soil Science, Botany, Forestry, Zoology, Fisheries, Entomology, Agriculture, Crop-plants, Plant Industry, Animal Industry, General Health and Medicine, Human Diseases, Health and Population, Anthropology.

There follows an alphabetical list of 192 authorities who have assisted by providing information or commenting on the drafts, also 73 governmental departments in British Africa which were helpful.

There is a 64-page bibliography, arranged alphabetically by chapters, an index and a physical map of Africa.

In various chapters of the book, the author refers to important work being carried on by the Royal Botanic Gardens at Kew in botanical investigations, the Imperial Forestry Institute at Oxford in forestry, forest organization of the Union of South Africa, British Museum (South Kensington) in Zoology and Entomology, the Zoological Society with its largest collection of living African mammals, the Society for the Preservation of the Fauna of the Empire stressing conservation, the four National and Provincial Museums in South Africa in Zoology, the Bureau of Animal Population at Oxford in ecology, the Imperial Institute of Entomology in the identification of insects, the East African Agricultural Research Station at Amani—one of the projected control research stations in the Tropical Empire—the London and Liverpool Schools of Tropical Medicine, and the Bureau of Hygiene and Tropical Diseases that abstracts articles of interest to Empire workers.

In this book Mr. Worthington has most effectively set forth the interrelation between sciences in Africa, the part they can play in its further development and the importance of scientific knowledge in coping with such problems as erosion, locust plagues and sleeping sickness.

One is impressed by the enormous job there is to be done and what a good start has been made on several fronts.

If we grant that the author has attempted to cover too wide a field within the covers of a single volume, nevertheless the title is misleading. Applied science in British or South African controlled territories, south of but not including the Anglo-Egyptian Sudan, would more nearly apply to the areas and subjects treated in the book. In most sections French, Belgian and Portuguese territories have been sketchily dealt with if they are mentioned at all.

The author in his own preface states that a shortage of time has resulted in the omission of much interesting work and that there is consequently a lack of proportion in the treatment of some subjects. This is unfortunately true. For example, such sections as the ones dealing with soil science, applied entomology, crop-plants or the plant industry are competently dealt with, whereas his chapter on anthropology or his treatment of the preservation of flora and fauna seem by the same standard to be extremely inadequate.

It is extraordinary that in a survey of this kind significant scientific reports on African research by American and other foreign investigators should have been completely overlooked and not even find a place in the bibliography; for example, Dr. Richard P. Strong's two-volume report on "The African Republic of Liberia and the Belgian Congo," published in 1930, covering a wide range of scientific subjects reported on by competent investigators in the fields of medicine, botany, entomology and zoology, and Dr. Wilfred D. Hambly's two-volume "Source Book for African Anthropology," published in 1937 by the Field Museum of Chicago.

In "Science in Africa" mollusks and invertebrates outside of insects are hardly mentioned at all.

Mr. Worthington has succeeded in producing a readable book covering a wide range of interest written in a uniform style, and at the same time valuable for reference on account of its splendid double index, helpful maps and bibliography as well as the thoroughly sound recommendations which he makes in his opening (not concluding) chapter. It is most fortunate that such a competent zoologist was selected for this task and that he was a man of such wide

vision with a sound critical judgment. Let us hope that many of his excellent recommendations may be favorably acted upon in the years to come.

HAROLD J. COOLIDGE, JR.
MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS.

THE ADVANCE OF MEDICINE

Thus We Are Men. By SIR WALTER LANGDON-BROWN, emeritus professor of physic and fellow of Corpus Christi College in the University of Cambridge. xii + 344 pp. Kegan Paul, Trench, Trubner and Co., Ltd., London, 1939. 10s. 6d.

The March of Medicine. Selected Addresses and Articles on Medical Topics, 1913–1937. By RAY LYMAN WILBUR, president of Stanford University, California. x + 280 pp. 1938. $2.75.

Milestones in Medicine: Laity Lectures of the New York Academy of Medicine. Introduction by JAMES A. MILL, president of the New York Academy of Medicine. vii + 276 pp. D. Appleton-Century Company, New York, 1938. $2.00.

THESE three volumes have a certain similarity in that they illustrate the manner in which various and diverse individual essays may be integrated about a single theme. This is an increasingly popular way by which busy intellectual leaders may coordinate a series of brief efforts about a more general philosophy.

Sir Walter's volume is deliberately planned in this spirit. Its general theme is stated in the first essay, the 1936 Maudsley Lecture, "The Biology of Social Life," in which it is pointed out that the demands of human evolution for a functioning social unit combining full cooperation with individual freedom are currently causing great stress as we bumble along in trial and error toward a surviving fitness. Psychological factors impose the greatest obstacles in this evolutionary process. To proceed we should learn more about our minds and the way they work. As Sir Thomas Browne phrased it three centuries ago, "Thus we are men and we know not how." Sir Walter's next essay has the provocative title, "We Have Reason to Think." He deals with the perplexing phenomenon of the "retreat from reason" in literature and politics on the basis of individual failure to evolve smoothly from infancy to manhood.

About this theme Sir Walter now plays many variations. A set of six essays deal with psychological states as illustrated from literature and science. The fascinating character of these studies is indicated by the titles: "Myth, Phantasy, and Mary Rose," "Robert Bridges—the Poet of Evolution," "Sir William Osler," "The Psychology of Authorship," "Dr. Jekyll Diagnoses Mr. Hyde" and "The Background to Harvey." In the latter it is recalled that Sir Thomas Browne (1606–1682) first used the word "electricity" and that he was an experimental scientist of considerable merit, especially in chemical embryology.

Another set of six studies deals with applications of this social and psychological evolutionary idea to art and religion. The discussion on "The Evolution of Death" brings the volume to a notable climax. Sir Walter's great scientific and literary ability make these essays stimulating and delightful reading.

President Wilbur's volume includes twenty-nine addresses delivered at various important functions since 1913 and dealing generally with current non-technical problems of biology, medicine and public health. Many of the earlier ones contain much wisdom resulting from years of experience on methods of teaching in medicine. The later ones are more concerned with the economic consequences of medical advance, and with the social significance of public health. As chairman of the Committee on the Costs of Medical Care, Dr. Wilbur summarized his views on these matters in his address before the National Conference on the Costs of Medical Care, at the New York Academy of Medicine, November 29, 1932.

For several years the New York Academy of Medicine has sponsored a series of "Laity Lectures" in which distinguished leaders in various medical fields have summarized recent significant developments in lay terms, or have dealt historically with interesting and practically important lines of progress. In 1936 the lectures were collected in a volume entitled "Medicine and Mankind," and included surveys of anatomy and physiology, an account of the medicine of the Amerinds, constitutional make-up in relation to disease, vitamins and a Carrel mystification on death. The 1937 lectures have now been published under the title "Milestones in Medicine." These titles are not quite appropriate. The books might better be titled "Laity Lectures in Medicine," giving then the year so that the series might be kept distinct.

The current volume includes an historical survey of psychiatry by Smith Ely Jelliffe, a discussion of the mechanisms of heredity by Charles R. Stockard, a diverting discussion of medicine at sea in the days of sail by Karl Vogel, a description of the evolution of the human brain by Frederick Tilney, a stimulating and documented "history of medical history" by Henry E. Sigerist, a historic account of leprosy by Newton E. Wayson and a survey of current knowledge of the glands of internal secretion by Walter Timme. Non-medical scientists will find that these essays afford a pleasant way to follow the historical development of medical ideas. Judicious documentation might add to their value for this purpose without detracting from their readability.

CHAUNCEY D. LEAKE
MEDICAL SCHOOL, UNIVERSITY OF CALIFORNIA,
SAN FRANCISCO, CALIF.

SOCIETIES AND MEETINGS

HE SEISMOLOGICAL SOCIETY OF AMERICA—EASTERN SECTION

THE Eastern Section of the Seismological Society America held its fourteenth annual meeting in eeman Hall on the campus of Fordham University, w York City, June 9 and 10, 1939. The Reverend seph Lynch, S.J., well-known seismologist and head the department of physics, welcomed the guests and mbers of the section.

The sessions were officially opened on Friday morn- at 9:15 by the chairman, H. E. McComb, of the S. Coast and Geodetic Survey. To allow time for e informal discussion and a tour of some of the ntific exhibits of the World's Fair, a departure was de from the usual procedure. Two days are custo- rily devoted to the presentation of committee re- ts, election of officers and the reading of papers. s year the seismologists continued in session until 5 in the evening, completing the scheduled program stopping only long enough at 1:30 to enjoy a buf- luncheon as guests of the university. Because of warm weather the lunch was served in one of the ment laboratories, where suction flasks and pyrex kers provided the necessary "scientific" atmosphere. eassembled again at 2:30 P.M., the delegates re- ed with presentation of papers and reports. Ani- ed discussion attended the reading of the report of committees on microseisms and amateur seismology the paper of A. C. Chick, Providence, R. I., on nds in Earthquake Insurance since 1933." Other papers of special interest should be mentioned: "The Nature and Origin of Microseisms," by J. Emilio Ramirez, S.J., of Bogotá, Colombia; "The Problem of Earth Deformation," by M. King Hubbert, Columbia University, and a report by A. G. Ingalls, of the editorial staff of the *Scientific American,* on "Amateur Seismology." The formal meeting was terminated by the reports of the resolutions and nominating committees and the election of officers for the ensuing year. The unanimous choice was as follows: *Chairman,* A. C. Ruge, of the Department of Civil Engineering, Massachusetts Institute of Technology; *Vice-Chairman,* A. J. Westland, S.J., Department of Physics, Spring Hill College; *Secretary,* W. A. Lynch, Department of Physics, Fordham University; *Treasurer,* H. Landsberg, Geophysical Laboratory, Pennsylvania State College; *Fifth Member of the Executive Committee,* H. E. McComb, of the U. S. Coast and Geodetic Survey.

At 10 o'clock Saturday, June 10, practically the entire group assembled again for a three-hour informal discussion of current seismological problems. Topics of timely import were, a new speed control for seismograph drums, demonstrated by A. C. Ruge; the necessity of putting all our seismographs to work; the new instruments and equipment at cooperative stations of the U. S. Coast and Geodetic Survey; the need for more sensitive instruments in the Gulf Coast States.

A. J. WESTLAND, S.J.

SPRING HILL COLLEGE,
SPRING HILL, ALA.

SPECIAL ARTICLES

TUDIES IN THE PHYSICAL CHEMISTRY OF INSULIN[1]

THE SOLUBILITY AND DIELECTRIC PROPERTIES OF INSULIN AND ITS CRYSTALLIZATION WITH RADIOACTIVE ZINC

SULIN, which can be crystallized in a state of high y, and possesses unusual chemical stability, as as specific physiological properties, is a very suit- protein for quantitative physical chemical studies. paper gives preliminary results of a series of tigations in progress in these laboratories upon hysical chemical properties of insulin and its in- tion with ions and dipolar ions.

ystalline zinc insulin[2] was dissolved in sufficient hydrochloric acid to bring the final pH to 2.5, rom the Department of Physical Chemistry, Harvard cal School, and the Jefferson Physical Laboratory, rd University.

urnished through the kindness of Eli Lilly and any.

electrodialyzed against N/300 hydrochloric acid in a Brintzinger type electrodialyzer for four hours, and then freed from acid by continuing the electrodialysis against distilled water for twenty hours. The protein precipitated in amorphous form; the supernatant solution had a conductivity of about 3×10^{-6} ohm^{-1} cm^{-1} and was chloride-free. The insulin was washed with conductivity water.

Measurements of solubility in water and glycine solutions were carried out at 5° by rotating portions of amorphous insulin prepared in the above manner with successive aliquots of solvent. After each equilibration, lasting from two to eight days, the suspension was allowed to settle, and the supernatant solution filtered through sintered glass. Analysis was performed by precipitating the insulin with trichloracetic acid, washing free of solvent with dilute trichloracetic acid solution, digesting the protein and determining the nitrogen colorimetrically with Nessler's reagent.

The solubility in water of insulin thus prepared never exceeded 0.027 grams per liter, but diminished to approximately a third of this value upon repeated equilibration with water. Although denaturation of the insulin with prolonged washing is not precluded, pharmacological activity[3] had not diminished in a sample which had been washed fifteen days, the solubility of which had decreased to 0.014 grams per liter. The average solubilities, when a constant level had been reached, are designated by the hollow circles in Fig. 1, initial solubilities by circles with crosses.

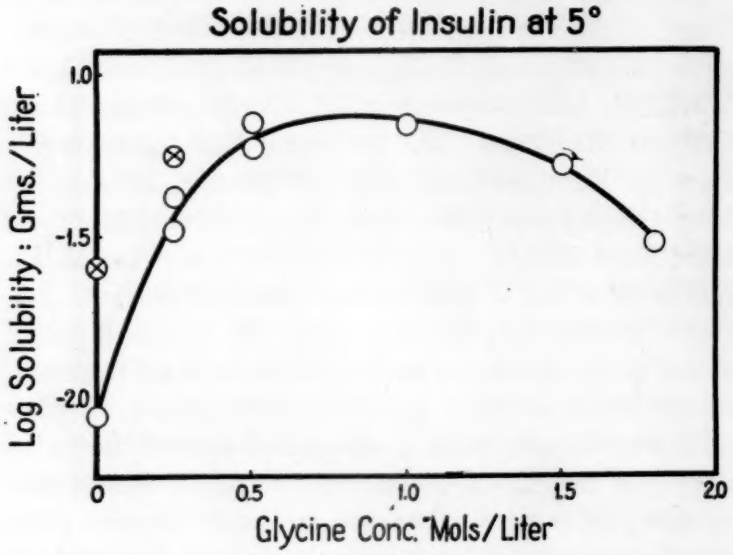

FIG. 1

Solubility of insulin in solutions containing 0.5 M glycine or more did not diminish upon re-equilibration with solvent, but remained constant for as many as nine equilibrations over a period of thirty days. These solutions saturated with insulin always had a pH close to 6.1, characteristic of pure glycine, rather than of the isoelectric point of the insulin. The average solubility was 0.065 grams per liter in 0.5 M glycine, 0.069 grams per liter in 1.0 M, 0.052 grams per liter in 1.5 M and 0.030 grams per liter in 1.8 M glycine. The occurrence of maximum solubility at a glycine concentration not greater than 1.0 M indicates a large "salting-out" effect. Indeed, the solubility in 1.8 M glycine is smaller than in 0.5 M glycine, whereas for hemoglobin[4] the "salting-out" effect reduces solubility at this concentration only to approximately that in 1.0 M glycine. The observed solvent action of glycine upon insulin, if corrected for the "salting-out" effect by an equation comparable to that previously employed for hemoglobin ([5], equation 5), would suggest interaction between these two dipolar ions somewhat greater than observed for hemoglobin. Lactoglobin has thus far been studied[6] only at glycine concentrations lower than half molal, where no "salting-out" effect could be detected and the observed interaction was far greater than with insulin or hemoglobin.

The rôle of the dipole moments in the interactions of dipolar ions has previously been stressed.[5] Taking the dipole moment of glycine as 15, that of hemoglobin[7] has been estimated as 500 and of lactoglobulin as 700, on the basis of measurements of dielectric constant increments of 0.33 and 1.4, respectively, per gram per liter.

The concentration of insulin prepared as above, even in 1.0 M glycine, is too low to contribute appreciably to the dielectric constant of the solution. Accordingly electrolyte-free solutions of insulin in quantities sufficient to study its dielectric properties were prepared in other solvents. Solutions of 1.9 grams per liter in propylene glycol, 3.2 grams per liter in propylene glycol containing 10.2 per cent. and 3.6 grams per liter in propylene glycol containing 20 per cent. of water were studied. The total dielectric increments from high to low frequencies, $\Delta\varepsilon_i$, were 0.26, 0.29 and 0.[illegible] per gram per liter, respectively, in these three solvents. The dispersion curves are given in Fig. 2, where the

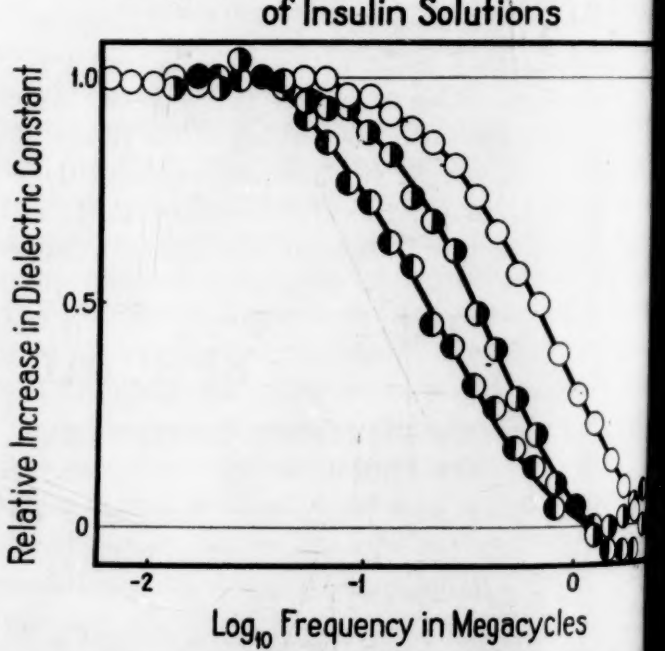

FIG. 2. Dispersion of the dielectric constant of insulin at 25° C. in ◐ propylene glycol (viscosity relative to water, $\eta_r = 47.5$), ◑ propylene glycol with 10.2% water ($\eta_r = 28$), ○ propylene glycol with 20% water ($\eta_r =$ [illegible]

relative increase in dielectric constant is plotted against the logarithm of the frequency. The mean relaxation times in the three solvents, when divided by the viscosities relative to water, agreed within 10 per cent. the average value being 1.7×10^{-8} seconds.

The viscosities and dielectric constants of these so-

[3] As judged by mouse test, for which we are indebted to Dr. W. T. Salter, of the Department of Medicine, Harvard University.

[4] M. M. Richards, *Jour. Biol. Chem.*, 122: 727, 1938.

[5] Cohn, McMeekin, Ferry and Blanchard, *Jour. Phys. Chem.*, 43: 1, 1939.

[6] Ferry, Cohn, Oncley and Blanchard, *Jour. Biol. Che*[illegible] Proceedings (1939).

[7] J. L. Oncley, *Jour. Amer. Chem. Soc.*, 60: 1115, 1[illegible]

tions differ so greatly from those of water that insulin is also being studied in other solvents, such as aqueous solutions of serum proteins in which it is appreciably soluble. The far lower solubility of insulin in water than in propylene glycol, a type of behavior characteristic also of zein, indicates that insulin may be considered a crystalline animal prolamine.

After repeatedly electrodialyzing crystalline zinc insulin in the preparation of the amorphous material used in the above experiments, it occurred to us to recrystallize the amorphous insulin with radioactive zinc. For this purpose a sample of zinc containing the radioactive Zn^{65} isotope, of half-life 250 days, was employed.[8] The electrodialyzed insulin was crystallized with radioactive zinc from acetate buffers, and amorphous commercial insulin was crystallized from phosphate and recrystallized from acetate buffers, following the method of Scott.[9] The radioactivity of the dried crystals was determined with a Lauritsen type quartz fiber electroscope. The radiation was filtered through 2.35 mm of aluminum in order to record only the gamma rays, which are much less affected than beta particles by self-absorption in samples of varying bulk. Comparison was made in each case with a standard sample of zinc sulfide or zinc ammonium phosphate prepared from the same sample of zinc. Under the conditions of electrodialysis given above, no more than 0.31 per cent. radioactive zinc was detected in our final products of crystalline insulin. Scott reports that crystalline zinc insulin contains 0.52 per cent. zinc. In order to determine whether our lower content of radioactive zinc depended upon incomplete removal of zinc by electrodialysis under the conditions employed, a commercial amorphous preparation[10] believed to contain not more than 0.03 per cent. Zn was crystallized with radioactive zinc. These crystals were estimated to contain 0.36 per cent. radioactive zinc.

Further experiments with radioactive zinc will be undertaken in order to determine the maximum content of radioactive zinc that can be introduced into crystalline insulin, and the conditions under which the zinc can be removed from insulin by dialysis or electrodialysis in acid or neutral solutions, or by interchange with blood and tissue proteins. Our experiments thus far indicate that none of the radioactive zinc introduced into insulin is removed at neutral reactions by electrodialysis or prolonged dialysis, but that at the isoelectric point of insulin the radioactive zinc is quantitatively adsorbed to normal horse serum. When, however, insulin containing two atoms of radioactive zinc per mole was separated from serum at neutral reaction, by precipitation with the protamine, salmin,[2] the resulting precipitate retained 0.14 per cent. radioactive zinc, corresponding approximately to a mono-radioactive zinc insulin protaminate.

EDWIN J. COHN
JOHN D. FERRY[11]
J. J. LIVINGOOD
MURIEL H. BLANCHARD

[8] Livingood and Seaborg, *Phys. Rev.*, 55: 457, 1939.
[9] Scott, *Biochem. Jour.*, 28: 1592, 1934; Scott and Fisher, *Biochem. Jour.*, 29: 1048, 1935.
[10] We are indebted to Dr. George B. Walden, of Eli Lilly and Company, for this material.

TYPE-SPECIFIC ANTIBODY PRODUCTION WITH LIVING PNEUMOCOCCI IN THE RABBIT

IT is generally held that only virulent strains are satisfactory as antigens for preparing antipneumococcus sera and that it is at least doubtful that immunization with living pneumococci is of value.[1] Griffith[2] writes that "living attenuated culture is useless for preparation of protective serum, and, as is known, this is due to the absence of type-specific antigen in such strains. This essential complex is liable to disintegration in living cultures, both prior to and subsequent to inoculation, with the result that non-type-specific antibodies are produced in the serum."

It was found recently[3] that a strain of attenuated tubercle bacilli, *Bacillus* Calmette-Guerin, induces antibody formation against virulent bovine tubercle bacilli more readily than heat-killed suspension of virulent micro-organisms. This observation stimulated us to determine whether living attenuated pneumococci are more effective immunizing agents than killed suspensions of virulent strains. Pneumococci of low virulence agglutinable by the type-specific antibody can be procured by repeated subcultures on blood bouillon and omission of the customary passage through mice. The first series of experiments were carried out with a Type III strain because sera against this type are of low potency and mouse-virulent strains are of relatively low virulence for rabbits. The lethal dose of the strain used is more than 20 cc for adult rabbits.

The centrifugalized sediment of five hours pepton bouillon cultures was suspended in 1 cc of bouillon per dose of "vaccine" and inoculated intravenously into rabbits weighing from two to three and one-half kilograms. Most of the rabbits received the sediment of 5 cc of culture on three successive days of the week for four weeks; later the doses were increased to 5, 5 and 10 cc. Agglutinin and precipitin titers of the sera of rabbits so immunized are considerably higher than those of animals immunized with killed suspension of cultures passed through mice frequently. Type-specific antibody nitrogen determination made by Dr. Kenneth

[11] Society of Fellows, Harvard University.

[1] B. White, E. S. Robinson and L. A. Barnes, "The Biology of Pneumococcus," The Commonwealth Fund, New York, 1938; H. Zinsser, J. F. Enders and L. D. Fothergill, "Immunity Principles and Application in Medicine and Public Health," The Macmillan Company, New York, 1939.

[2] F. Griffith, "A System of Bacteriology," Vol. II, His Majesty's Stationery Office, London, 1929.

[3] J. Freund, J. Casals and E. P. Hosmer, *Proc. Soc. Sxp. Biol. and Med.*, 37: 509, 1937; J. Freund and E. L. Opie, *Jour. Exp. Med.*, 68: 273, 1938.

Goodner of the Rockefeller Institute have shown in a small group of rabbits that the majority of the sera contained from one to two mg antibody nitrogen per cc, and one exceptional serum contained approximately 6.4 mg.

Similar experiments are being carried out with pneumococci of Type I. The results indicate that the method described above is applicable to production of Type I antipneumococcic serum.

JULES FREUND
MARTHA A. BEHAN

DEPARTMENT OF HEALTH
OF THE CITY OF NEW YORK
BUREAU OF LABORATORIES,
ANTITOXIN LABORATORY,
OTISVILLE, N. Y.

THE SIGNIFICANCE OF THE AMINO ACIDS IN CANINE NUTRITION[1]

IN previous publications from this laboratory[2,3] it has been shown that only ten of the twenty-two amino acids known to exist in proteins are *indispensable* dietary components. These are tryptophane, lysine, histidine, phenylalanine, leucine, isoleucine, threonine, methionine, valine and arginine. With the exception of arginine, the removal of any one of these compounds from the food leads to a profound nutritive failure, accompanied by a rapid decline in weight, loss of appetite and eventual death. On the other hand, the exclusion of arginine from the ration is followed by much less pronounced effects. The subjects continue to gain, but at a suboptimal rate. This is accounted for by the fact that arginine, in contrast to the other members of the indispensable group, can be manufactured by the cells,[4] but at a speed which does not quite keep pace with the demands of *normal* growth. The twelve remaining amino acids are dispensable in the sense that they can be synthesized in adequate amounts out of materials ordinarily available in the organism.

In arriving at the above conclusions young rats served as the experimental animals. Consequently, it does not follow necessarily that the findings are applicable to other species. Indeed, a *quantitative* difference in the arginine requirement has already been recorded in the literature. The growth of chicks is said to be accelerated by the addition of this amino acid to the ration, even when the latter contains 18 per cent. of casein[5] (equivalent to a dietary arginine content of approximately 0.68 per cent.). This amount of casein furnishes more than three times the quantity of arginine necessary for the growing rat.[2] It becomes of importance, therefore, to ascertain whether the rat is singularly proficient in the synthesis of amino acids, or whether other mammals also manifest the ability to thrive on relatively simple mixtures.

The nutritive rôle of the individual amino acids has now been established for the adult dog. This was undertaken as a preliminary to extensive investigations on the maintenance of nitrogen equilibrium in various species by oral and intravenous alimentation. The program has advanced sufficiently to warrant a brief report at this time. The experimental findings and the details of the technique will be presented elsewhere.

Adult females were used throughout. As a rule, they were first brought into nitrogen equilibrium upon a casein diet, and were then transferred to a similar ration in which mixtures of highly purified amino acids served as the sole sources of nitrogen, except for traces introduced unavoidably as contaminants of the vitamin B concentrates. The urine samples were collected by catheterization at intervals of twenty-four hours, and the feces were divided into periods of seven days by the administration of carmine capsules.

The first dog received a ration containing the ten amino acids found previously to be indispensable for the growing rat. She promptly manifested a slight positive nitrogen balance, and continued to do so, with a moderate gain in weight, for the duration of the test (4 weeks). Obviously, *the amino acids which are dispensable for the growing rat are also dispensable for the adult dog.* At the beginning of the fifth week, arginine was dropped from the diet. The change was without influence upon either the body weight or the nitrogen balance of the subject. Thus, *for the adult dog arginine is not a necessary dietary component.* This finding was not unexpected. Nearly two years ago we[3] predicted that arginine would prove to be dispensable for full-grown animals. The experiment was discontinued at the end of the eighth week, at which time the dog was in perfect nutritive condition.

Three dogs were employed in determining the physiological importance of the other amino acids of the indispensable group. Invariably, the removal from the food of any one of these compounds was followed by a pronounced negative nitrogen balance. Furthermore, the restoration of the missing amino acid to the diet uniformly resulted in a positive nitrogen balance. These data demonstrate that *the qualitative amino acid needs of the dog are identical with those of the rat.* The fact that two widely different species require for their well-being the same components of the protein molecule, increases the probability that other mammals, including man, may manifest like responses.

In the experiments herein described the amino acid

[1] The researches upon which this report is based were supported in large measure by a grant from the Rockefeller Foundation.

[2] W. C. Rose, SCIENCE, 86: 298, 1937.

[3] W. C. Rose, *Physiol. Rev.*, 18: 109, 1938.

[4] C. W. Scull and W. C. Rose, *Jour. Biol. Chem.*, 89: 109, 1930.

[5] A. Arnold, O. L. Kline, C. A. Elvehjem and E. B. Hart, *Jour. Biol. Chem.*, 116: 699, 1936; A. A. Klose, E. L. R. Stokstad and H. J. Almquist, *Jour. Biol. Chem.*, 123: 691, 1938.

intakes, though low, were not reduced to the minima. Repeatedly we[2,6,7] have pointed out that mixtures of purified amino acids, compounded in accordance with the quantitative needs of the cells for each component, may prove to be the most efficient type of nitrogen ever devised for the uses of the animal organism. For some time investigations have been in progress[7] to establish the lowest intakes of such preparations which are capable of maintaining nitrogen equilibrium in the rat and in the dog. The results will be reported later.

Inasmuch as the successful use of synthetic mixtures of amino acids in nutrition studies was made possible by the discovery of threonine in this laboratory, it seems not inappropriate to expect that a reasonable period of time will be allowed for the consummation of the program outlined above before similar studies are undertaken by others.

WM. C. ROSE
ELDON E. RICE

UNIVERSITY OF ILLINOIS, URBANA

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DEEP-SEA PHOTOGRAPHY

INTEREST in deep-sea animals had led me to assemble an automatic camera mechanism in a pressure chamber[1] capable of withstanding two miles of depth in the sea, two tons per square inch, with a considerable safety factor. In this self-contained device, two six-volt storage batteries supply the current to run the motor (12 volts) for a 16 mm moving picture camera, a 50 candle power headlight with reflector (8 volts), and a timing motor (4 volts). The light shines through one "herculite" glass window, while the camera takes pictures through another. A pressure gage with electric contacts, which can be set for any depth, activates the mechanism by means of a lock relay. This starts the timing motor whose contacts turn on the movie camera and light (each through a separate relay) for 1.2 second and then turn them off for 11.1 seconds, when the process is repeated. The camera is set to take 16 pictures a second, and the films when developed show 20 light frames between 3 dark ones, since the filament takes some time to reach incandescence and the motor some time to stop. In 100 feet of film, there are about 170 chances of photographing something. Since the pictures are taken in the zone of perpetual darkness, a lure is hung 4 feet in front of the pressure chamber and the camera with stop f 1.5 focused on it. This lure is a wooden fish resembling a deep-sea fish, with rows of photophores painted on it with self-luminous zinc sulfide paint.

In June, through the kindness of Dr. J. F. G. Wheeler, of the Bermuda Biological Station for Research, I had the opportunity of testing the camera, which was let down from the ketch, *Culver,* permanently stationed in Bermuda for oceanographic work under the auspices of the Royal Society of London. Five descents were successfully accomplished in the region 5 to 10 miles southeast of Bermuda, where Beebe[2] has made over 1,500 hauls with nets and many descents with the bathysphere. Three 100-ft rolls of super XX panchromatic film were taken at 500 fathoms, one at 800 fathoms, and one at 1,320 fathoms (1½ miles). In the latter, the chamber touched bottom (although the chart indicated plenty of depth), knocking off a support and turning the camera out of position so that nothing appeared on this film. The other four films showed the lure clearly but no fish or large organisms. However, 17 small creatures, the largest about one centimeter in diameter, too small to be identified, moved across the beam of light in the 300 feet of film taken at 500 fathoms, the depth where Beebe obtained most material in his hauls with the nets. The film at 700 fathoms only showed two small creatures.

Since the lens angle of the camera subtended a rectangle 8×11 inches at 2.5 feet and 20.5×26 inches at 6 feet, the depth of focus for f 1.5 stop, we can think of the camera as sampling a frustum of about 7 cubic feet or one fifth of a cubic meter. Because of the drift of the boat, 510 samples were made in the three films exposed at 500 fathoms and 17 organisms photographed. This is one medium-sized organism per 30 samples or 210 cubic feet (6 cubic meters) of sea.

While no striking photos were obtained of deep-sea fish attacking the lure or one another, the experiments show that deep-sea photography is quite feasible and might be developed into a method of estimating the density of organisms at different depths.

E. NEWTON HARVEY

PRINCETON UNIVERSITY

A GLASS ELECTRODE VESSEL FOR THE DETERMINATION OF BLOOD pH

THE Beckman pH meter may be employed effectively in estimating the pH of whole blood under anaerobic conditions through the use of a special glass electrode assembly. The determination can be made directly on

[6] W. C. Rose, *The Harvey Lectures,* 30: 49, 1934–35.
[7] W. C. Rose, *Proc. Inst. Med. of Chicago,* 12: 98, 1938.
[1] It gives me great pleasure to acknowledge the advice of Dean Greene and Dr. Moody, of the Engineering Department of Princeton University, in the design of the pressure chamber, which was a most acceptable gift of Mr. Owsley Brown, president of the Springfield Boiler Company, manufacturers of the chamber. To Mr. Charles Butt, research assistant in physiology, I am grateful for skilful arrangement of the wiring mechanism.
[2] Wm. Beebe, "Half Mile Down," Harcourt, Brace and Company, New York, 1934.

the blood within 40 to 50 seconds after collection. In a series of determinations made upon dogs, we have obtained consistent and readily reproducible results.

A small glass vessel, illustrated in the figure, was made, having two side arms. This vessel may be attached to the standard Beckman glass electrode by winding firmly with thin rubber dam and fastening with rubber cement. After a little practice an air-tight connection can readily be made. If the Beckman electrode with the ground glass collar is available, the

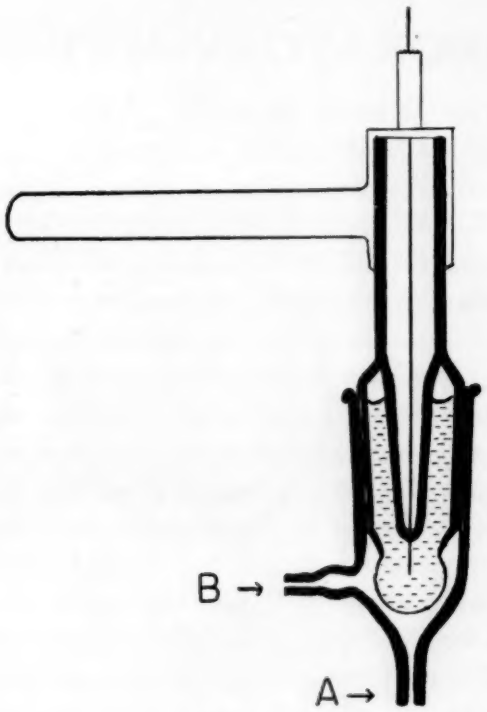

FIG. 1

vessel may be ground to fit this collar. The ground glass connection permits of more rapid adjustment and is more convenient for washing, but we have found the rubber connection to be perfectly satisfactory. The side arm, A, is attached by the shortest possible length of rubber tubing to a syringe adapter. If desired, this side arm may be made of a syringe tip, sealed into the cup, thus making a direct connection for the needle.[1] A ten-inch length of 3 mm rubber tubing attached to a mouthpiece is fastened to side arm, B, to be used in filling the vessel. The total capacity of such a chamber is 0.3–0.4 cc.

The procedure for performing a blood pH determination is as follows: Saturated KCl solution is warmed to 40° C. and placed in a small wide-mouthed vessel of about 50 cc capacity. This is supported so that the calomel half-cell dips into it and a thermometer is immersed in the solution, which serves as a bath and a salt bridge. Sufficient 1 per cent. neutral oxalate (pH 7.0) at 38° C. is drawn through A into the electrode vessel and a small clamp placed on the rubber tubing near the mouthpiece. A venipuncture is made with a hypodermic needle and when a constant flow of blood is obtained, the chamber is attached to the needle and the blood drawn into the vessel by opening the clamp and exerting suction on the mouthpiece. From 0.5–0.7 cc of blood is drawn into the vessel and tubing to insure complete replacement of the oxalate. It is essential that the chamber remain free from air bubbles. The electrode is disengaged from the needle, plunged immediately into the bath and the connection made rapidly. The temperature of the bath will usually have fallen to 38° C. and can be checked with the thermometer and adjusted, if necessary, by adding warmer or colder KCl solution. A steady E. M. F. is obtainable within 30 to 40 seconds after the electrode is attached to the pH meter.

As soon as the reading is obtained the electrode is removed and the vessel washed free of blood by drawing in warm distilled water. It is then rinsed and refilled with oxalate in preparation for the duplicate determination. During the interval necessary for the pH reading and the washing of the vessel a syringe may be attached to the needle and a blood sample taken for analysis. This total procedure can be done in from 2 to 4 minutes. When stasis is avoided, duplicate determinations check within the error of the instrument (± 0.01 pH). If this agreement is not obtained, a third determination should be done. Before each determination, we find it advisable to calibrate the electrode with standard buffers in the pH range of blood at 38° C., using the procedure as outlined for blood.

VIVIAN G. BEHRMANN
MARION FAY
WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA

[1] Both types of vessel were made for us by Mr. J. D. Graham, at the University of Pennsylvania.

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